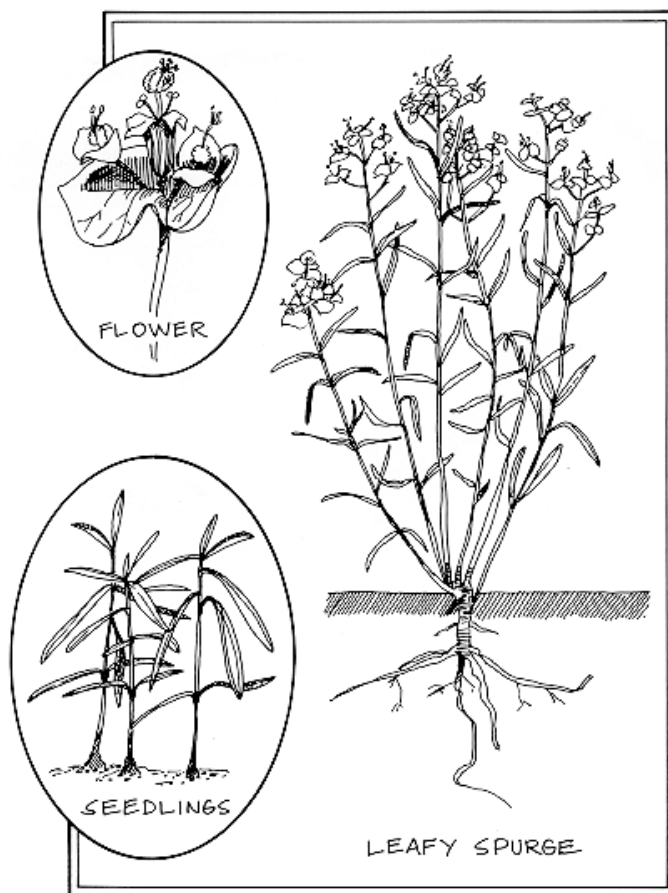


LEAFY SPURGE *Euphorbia esula*

Life History/Identification:

Leafy spurge is a long-lived perennial plant that reproduces both by seeds and by an extensive vegetative root system. The main roots usually extend about 8-10 feet down and 15 feet outwards in a year, but have been known to grow to nearly 30 feet deep! The tough, woody, hairless stems grow to be about 1-3 feet tall and form dense clumps (clones). The leaves are 1"-4" in length, are somewhat narrow (1/4" wide) flattened and have smooth edges. The main body of the leaf is attached directly to the stem. All parts of the plant contain a sticky, milky sap. The flowers are produced in clusters at the ends of branches and each cluster of flowers is surrounded by a group of small, broadly rounded, pointed, yellowish-green leaves that decrease in size towards the tip of the branch where the flowers are found. The fruit of this plant is in the shape of a three-lobed, warty, green capsule. A single seed is formed in each lobe of the capsule. While most seed production is the result of cross-pollination, self-pollination can produce viable seed in great numbers. One study estimated that within one dense patch of leafy spurge, 2500 seeds were produced in a single square meter of land. The seeds are forcibly ejected from the capsules and can travel up to 15 yards from the parental plant. Seeds in soil remain viable 5-8 years. Despite the potential for great amounts of seed production, vegetative reproduction is the primary means by which this species takes over an area. Leafy spurge may be confused with native spurges, *Euphorbia lurida* or *Euphorbia chamaesula*. To ensure correct identification, take a sample of the plant to the Deaver Herbarium in the NAU Biology building, Room 314.



Flagstaff Localities:

Only one general area of infestation is known in the Flagstaff region and it is located on Forest Service land at Brolliar Park beyond Mormon Lake. The infested area is being treated with various mechanical and grazing control methods.

Economic Impact:

This species was introduced to North America along the New England coast in the early 1800's. It most likely arrived as a contaminant in ship ballast. Subsequent introductions associated with contaminated grain shipments led to its spread across the northern part of the US, south to California and Arizona, and through much of central and western Canada during this century. Leafy spurge has become a serious weed in most western states because it tolerates a broad range of growing conditions. It is often associated with open habitats and is equally at home on dry sandy soils as on moist heavy clays. A common invader of grain fields, pastures, and roadsides, this species is quite capable of invading native prairies and open woodlands. In 1990, annual losses of all kinds attributable to leafy spurge in the US alone were estimated to have reached \$92 million. The carrying capacity of infested areas may be reduced by as much as 75% because wildlife and cattle will not graze heavily infected areas. Bison, elk, and deer have been shown to graze areas containing

leafy spurge, but cattle develop scours and weakness while horses develop blistering and hair loss on their feet after grazing on leafy spurge. In some areas, the cost of control has exceeded the original cost of the land.

Control:

The well-developed food storage system of the roots allows this plant to withstand many individual control methods. Herbicides are not always the most practical method due to the cost of spraying large areas and because leafy spurge may grow near water or environmentally sensitive areas where herbicide spraying is restricted. An integrated program of control is recommended because no single method can completely control the spread of leafy spurge.

Cultural Control:

Properly timed cultivation and/or planting of competitive grass species can be effective against leafy spurge. However, cultural practices are more effective when combined with herbicide treatments. The grass species found to compete successfully with leafy spurge in some northern states include wheatgrass, wild rye and smooth brome, but competitive species will vary with area. Because introduction of leafy spurge is often associated with contaminated hay or grains, it is best to buy only certified weed free hay and grains. Cars, trucks, people and livestock that have passed through an infested area should be checked upon leaving the area for any stray pieces of leafy spurge plants.

Mechanical Control:

Due to the deep roots of this species, attempts at removing these plants through mowing, hand pulling and tilling have proven to have very limited impact. Pieces of roots 1/2" in length and 1/10" in diameter can produce new shoots. Mowing can reduce seed production if carried out every two to four weeks during the growing season. The use of fire combined with herbicides has been shown to be an effective control against leafy spurge because the growth that develops after a burn is more susceptible to an herbicide application.

Chemical Control *(These are chemical control techniques that have been used in other areas. Always check with weed specialists or chemical suppliers before treatment to ensure correct dosage and application. Mention of these products does not imply endorsement by the Northern Arizona Weed Council or The Nature Conservancy.):*

- 1) Tordon™ (Picloram) at 1-2 pints per acre (0.25 to 0.5 pounds per acre) plus 2,4-D at 1 pound per acre (1 quart of a 4 pound-per-gallon concentrate). This treatment will provide 90 percent or greater control in 3-5 years when applied annually. Timing of treatment: mid June when true flowers appear and, if needed, September when re-growth occurs.
- 2) Dicamba (Banvel™), glyphosate + 2,4-D (Landmaster BW™), dichlobenil (Norosac™), fosamine (Krenite™), and glyphosate (Roundup™ and Rodeo™ formulations) are also labeled for leafy spurge control in some areas. Several of these herbicides have specific uses such as near water, on non-cropland, or near trees. It is recommended that glyphosate or glyphosate plus 2,4-D be applied once or twice during June and July before seeding with perennial grasses. Early applications of these herbicides will reduce the vigor of leafy spurge and other weedy species.

Biological Control *(No exotic species should be introduced into an ecosystem without extensive research.):*

Currently, the use of sheep, goats, and insects are the only tested and approved biological control methods for leafy spurge. Unlike cattle, sheep and goats seem to suffer few or no ill effects from eating leafy spurge if it comprises 50% or less of their diet. Sheep were successfully used to reduce seed production in the Brolliar Park area in 1999 and 2000, however the infestation is still slowly spreading. It is necessary, however, to hold the animals in a corral before moving them to a weed free location in order to prevent infestation from viable seeds in the feces, or to remove them before viable seed are produced. Several other states have successfully used various host specific species of flea beetles to reduce leafy spurge populations, especially root-boring beetles.



Species Management Plan Leafy Spurge (*Euphorbia esula*)

Life History/ Identification: Leafy spurge is native to Europe and Asia. It was first reported in the U.S. in 1827 in Massachusetts. It has since spread throughout many parts of the country and into some areas of Mexico and Canada. Characteristics of leafy spurge include linear, alternate leaves and small yellow-greenish flowers that are surrounded by yellow bracts. The flowers of leafy spurge are small and inconspicuous and are surrounded by bracts. The true flowers emerge in April and

May but the bracts may be present prior to flowering. A milky white sap is present in the stems and foliage. The plants reach a height of 12 to 36 inches and have a deep underground rootstalk. Roots form an extensive network of rhizomes in the upper one to four feet of soil but can extend to a depth of 30 feet. Leafy spurge can reproduce from seed or vegetatively. New plants can arise from the vegetative buds on the rhizomes. Seed capsules on the plant eject the seeds forcefully when they become ripe. The seeds can travel up to 15 feet when ejected. Several native spurges in the Flagstaff area form distinct clumps when they grow. Leafy spurge differs from this, forming many individual distinct stems and large patches. This characteristic can be helpful in field identification. Leafy spurge can occur in a wide range of habitats including dry meadows, grasslands, grain fields, waste areas and forests. Plants emerge in the early spring from the base of the existing plants and from buds on the rhizomes.

Status: Leafy Spurge is recognized as a noxious weed on the Coconino, Kaibab and Prescott National Forests. It is recognized as a Prohibited Noxious Weed by the State of Arizona. According to the state regulations, prohibited weeds are not known to exist within the state.

Known Locations: Leafy Spurge is known in three locations on Coconino, Kaibab and Prescott National Forests. The largest population is at Brolliar Park on the Mormon Lake Ranger District, Coconino National Forest. This population was discovered in 1998 and covers at least 60 acres. There is a small population at Hull Cabin on the Tusayan Ranger District, Kaibab National Forest. This group probably covers less than 1/10 acre. A third population is known from near Big Springs on the North Kaibab Ranger District, Kaibab National Forest. A fourth population exists on private land in eastern Arizona.

Impacts: Leafy spurge out competes native species by emerging early, using the available water and nutrients, by forming large monocultures and through allelopathy. Leafy spurge has had significant impacts on rangelands in the United States and Canada. It can reduce the rangeland carrying capacity by 50 to 75 percent by out competing native grasses (Beck). Leafy spurge can be detrimental to some grazing animals. The sap can produce irritation in the mouth and digestive tracts of cattle. It can cause scours, weakness and death in cattle. Sheep and goats have been used as a biological control agent for this plant. However, some seeds can remain viable and be capable of sprouting after passing through the animals' digestive tracts can be transported in the fur. Birds, insects and animals can disperse seeds. Humans can disperse the seeds in clothing, personal gear and by driving through populations. The sap of leafy spurge may be hazardous to humans. It may cause dermatitis or eye irritation.

Control: Due to the pernicious nature of this species an integrated plan of management is necessary. The deep perennial taproots and root reserves make treatment of this species especially difficult. Repeated treatments over several years are necessary to control leafy spurge followed by a monitoring and maintenance plan.

1. Cultural Control:

Prevention of new populations is the most effective and least difficult method of control. Maintenance

of a healthy perennial grass community in uninfested areas is important. A healthy grass community is more able to out compete leafy spurge plants. Overgrazing can stress the grass plants and make them less competitive with all weeds including leafy spurge. Weed free hay may help prevent infestations. Hay transported from one area to another can be a source of weed infestation. Road closures or restrictions in infested areas can help prevent the spread of existing populations and infestation of new areas. Some road closures and restrictions are planned to help control the leafy spurge population at Brolliar Park. Some plants were growing in existing roadways where cars could easily pass over them and distribute the seeds to new locations.

Revegetation with more desirable vegetation is necessary. Plant competition with more desirable species is an important component of any leafy spurge plan. Native species are most desirable from an ecological standpoint.

2. Mechanical Control can labor intensive. Some methods of mechanical control are not practical to use on leafy spurge in the Coconino, Kaibab and Prescott National Forests. These include pulling and cultivation.

Hand pulling of leafy spurge plants is not a good method of control in established populations. The extensive root system is already present and pulling will likely only remove the above ground portions of the plants. Resprouting will occur from the rhizomes. Additionally, it may present a safety risk to the weed puller through contact with irritating sap. Hand pulling may be useful where single plants are present or in newly established populations if the root system is not yet well established. If this method is used the site should be monitored for future infestation and proper safety precautions such as gloves, long sleeved shirt and eye protection should be used.

Cultivation can control leafy spurge if it is done on a regular basis. However, if the cultivation is not done on a regular basis leafy spurge will reoccupy the site. This method is probably useful in agricultural fields but not applicable to most lands within the Coconino, Kaibab and Prescott National Forests. The treatment area would require regularly scheduled and repeated tilling and alternate vegetation would need to be planted on the site. Other resources such as archaeology, grazing and wildlife habitat would need to be considered.

Mowing and/or weed whacking can be used to control leafy spurge. This type of treatment will remove the top portions of the plants preventing seed formation. This method is useful in controlling the spread of the existing population by the seed source. However, the population at Park formed multiple side shoots after weed

To be effective the treatment must be repeated times during the growing season to ensure that not form. This treatment will not eradicate existing The extensive underground roots have abundant stores.



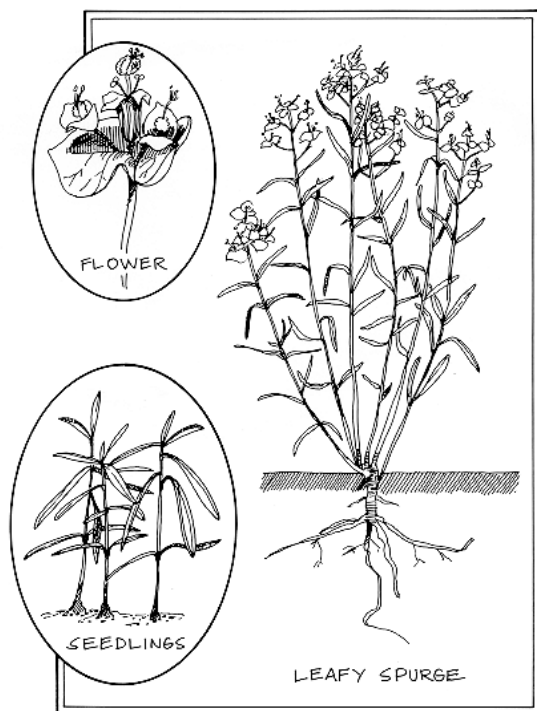
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Fire may be somewhat useful in controlling leafy spurge by the above ground portions of the plants. However, literature reviewed for the preparation of the Fire Effects Database was inconclusive. Various reports indicate an increase, decrease and no effect in plant response to fire. The above ground portions of the plants are removed but the underground rhizomes survive the fire. Fall burning has been done on a few sites but is less effective than herbicides. The database reports that leafy spurge is an off-site colonizer, moving into areas not previously infested after fire has occurred. This should be considered before any burning is planned.

3. Chemical Control: *Noted here are chemical control techniques in use in other areas. Always check with weed specialists or chemical suppliers to ensure correct dosage and application. Mention of these products does not imply endorsement by the Northern Arizona Weed Council, San Francisco Peaks Weed Management Area, the USDA Forest Service, nor the Nature Conservancy. Currently the use of herbicides is not allowed on lands administered by the Coconino, Kaibab and Prescott National Forests. Always check with your local land manager before using herbicides on public lands.*

Several **herbicides** have been used in other areas for control of leafy spurge. These include 2,4-D, Vanquish or Clarity (dicamba) and Tordon 22K (picloram). Applications should begin as soon as the true flowers emerge. Fall application to leafy spurge regrowth is also helpful. Roundup has been used for control of leafy spurge. However, since it is a non-selective herbicide it may also kill the grasses present. Leafy spurge will sometimes recover from treatment with Roundup. K.G. Beck suggested a follow up treatment with 2-4D if this happens. Grass seeding was necessary after treatment of an area with Roundup. Plateau can be used in non-crop areas but this herbicide will also injure cool-season perennial grasses.



4. Biological Control: Several organisms have the potential to control leafy spurge. Some of those organisms are described below.

Sheep and goats have been used to control leafy spurge infestations. Unlike cattle the sheep and goats seem to suffer few or no ill effects from eating leafy spurge if leafy spurge comprises 50% or less of the animals' diet. Sheep were used in the Brollier Park area to control that population in 1999. The herder reported no ill effects in the animals. It is necessary to hold the animals in a corral before moving to a weed free location to prevent infestation from viable seeds in the feces.

Several **insects** have been approved for release for leafy spurge control. The spurge hawk moth (*Hyles euphorbia*) is a defoliating moth. There are several species of beetles that feed on

various portions of the plant. Most are root-borers. These include four species of flea beetles (*Apthona nigriscutis*, *A. cyparissiac*, *A. czwalinae*, and *A. flava*). There is also a root boring beetle, *Oberea erythrocephala* and a gallfly *Spurgia esulae*.

In North Dakota a **fungus** (*Alternaria sp.*) collected from leafy spurge is being researched as a possible control agent.

Research has also been done on the use of **bacteria** that exist naturally in the roots of leafy spurge. Researcher Robert Kramer has identified bacteria that may suppress the emergence of leafy spurge plants in greenhouse studies by as much as 50%. This could hold future potential if there is a way to boost the number of existing bacteria in infested areas.

Two vascular **plant** species are being studied as potential control agents. These two species, small everlasting (*Antennaria microphylla*) and sun hemp (*Crotalaria juncea*) are allelopathic to leafy spurge.

The sheep and insects are tested and approved methods for control of leafy spurge.

However, no biological control agent should be released into the environment without proper testing and approval.

5. Integrated Control is the use of two or more methods at once to control the targeted species.

Herbicide treatment followed by **planting** of perennial grasses has been useful in some areas. Reseeding is necessary with some herbicides such as Roundup, which kills the grasses.

In the Brolliar Park area **sheep** have been used on the main population with **mowing or weed whacking** used on the smaller outlying populations. These actions will help control the existing populations.

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